

## **Municipal Solid Waste Management and Evaluation of Zero Waste Strategy in Ordu**

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### **Abstract**

Zero waste management is a broad concept that covers all areas that produce waste such as public institutions and organizations, local governments, industrial facilities, hospitals, educational institutions, tourism facilities and workplaces. In this study, the amount, composition, management and transition process to zero waste management system of municipal solid waste in Ordu were investigated. In Ordu, a coastal city of the Eastern Black Sea region, municipal solid waste is collected by the dual collection method and disposed of in a sanitary landfill. Approximately 69% of the municipal solid waste composition consists of organic waste and 7% consists of hazardous and non-recyclable waste. The recycling potential of municipal solid waste in the province is 24%. The zero waste approach has reduced the amount of solid waste going to landfills, increased the amount of waste going to recycling and facilitated energy recovery from non-recyclable waste in Ordu.

**Keywords:** Zero waste, Solid waste, Waste management, Recycling, Double Collection.

## **Ordu İlinde Kentsel Katı Atık Yönetimi ve Sıfır Atık Stratejisinin Değerlendirilmesi**

### **Öz**

Sıfır atık yönetimi, kamu kurum ve kuruluşları, yerel yönetimler, endüstriyel tesisler, hastaneler, eğitim kurumları, turizm tesisleri, işyerleri gibi atık üreten tüm alanları kapsayan geniş bir kavramdır. Bu çalışmada Ordu'daki kentsel katı atıklarının miktarı, karakterizasyonu, yönetimi ve sıfır atık yönetim sistemine geçiş süreci araştırılmıştır. Doğu Karadeniz'in sahil kenti Ordu'da kentsel katı atıklar ikili toplama yöntemiyle toplanarak düzenli depolama alanında bertaraf edilmektedir. Evsel katı atık kompozisyonunun yaklaşık %69'u organik atıklardan, %7'si ise tehlikeli ve geri dönüştürülemeyen atıklardan oluşmaktadır. İldeki evsel katı atıkların geri dönüşüm potansiyeli %24'tür. Ordu'da sıfır atık yaklaşımıyla düzenli depolama sahalarına giden katı atık miktarı azaltılmış, geri dönüşüme giden atık miktarı artırılmış ve geri dönüştürülemeyen atıklardan enerji geri kazanımı kolaylaştırılmıştır.

**Anahtar Kelimeler:** Sıfır atık, Katı atık, Atık yönetimi, Geri dönüşüm, İkili Toplama.

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## 1. Introduction

The amount and diversity of waste is increasing day by day in parallel with unregulated urbanization, technological developments and population growth. On a global scale, the amount of waste per person varies between 0.11 kg and 4.54 kg. The main reason for this difference is due to the income level, urbanization and development levels of the countries (Corvellec et al., 2022).

In 2016, 2.01 billion tons of municipal waste was generated. It is estimated that this figure will increase to 3.4 billion tons after the half of the 21st century (Zelenika et al., 2018). The use of packaged products and disposable materials, which are becoming more widespread day by day as a result of the differentiation of consumption habits, have become one of the biggest factors of the garbage problem, which has reached high levels today (Van Ewijkand Stegemann, 2016). The increase in urban population and the constant decrease in scarce resources have led countries into uncertainty. For this reason, in order to prevent the depletion of scarce resources, sustainable and strategic waste management system is needed (Zaman and Lehmann, 2013).

Waste management is a management style that includes prevention of waste generation, reuse, recycling, recovery (including energy recovery), disposal and monitoring-control processes. The waste management pyramid aims to limit the waste that will occur or is likely to occur with a strategy. In addition, the waste management pyramid is an effective management process that includes the separation, transportation and temporary storage of possible wastes at the source, allowing recovery or disposal processes to be carried out (Mandpe et al., 2023).

Solid waste management includes integrated solid waste management, sustainable solid waste management and zero waste approach (Diaz, 2017). Integrated solid waste management examines waste management issues in all their dimensions as a whole. It deals with all elements in waste management separately, in terms of efficiency levels and areas of activity. In the system, the purpose and targets to be achieved are clearly stated (Tsai et al., 2020). The purpose of the system is stated as "to keep the negative situations that may arise in the ecological and economic fields at a minimum level during the disposal process of the waste types that have been created". In order to implement the integrated solid waste system, it is important for the functioning of the system to determine the final goal to be achieved before the project begins and to create the planning phase effectively (Yaman ve Orhan, 2010).

The hierarchical structure of integrated solid waste management is as follows: primarily preventing waste, reducing waste, ensuring the reuse of generated waste, subjecting these wastes to recycling stages, recycling wastes and removing unused or recycled waste (Iqbal et al., 2020). It includes the stages of disposal of wastes whose recycling possibilities have disappeared. The goal of sustainable solid waste management is to ensure that the resources used to produce products or goods

are used in product production again, preventing the resulting waste materials from harming the environment and bringing them back into the economy (Margallo et al., 2015). Sustainable solid waste management consists of 4 steps that complement each other. The first of these refers to avoiding waste generation. Secondly, if waste generation cannot be prevented, it is the reuse of the resulting waste through recycling. Thirdly, it refers to the use of these wastes to produce energy if it is not possible to recycle them. Finally, it covers the process of applying the most appropriate environmental options for the disposal of waste generated as a result of these stages (Song et al., 2015).

In this study, the amount and composition of municipal solid waste in Ordu province was examined by years. The current solid waste management in the province was investigated and the work carried out during the transition to zero waste strategy was discussed in detail. The problems experienced within the framework of sustainable solid waste management have been revealed and solution suggestions have been offered.

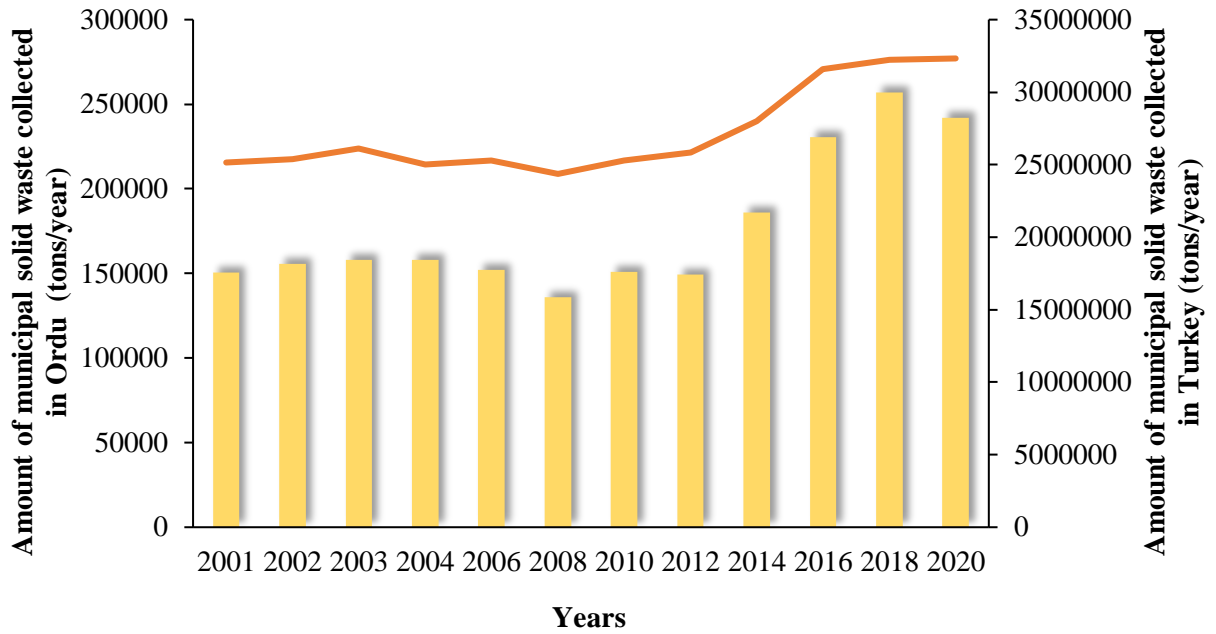
## 2. Amount of Municipal Solid Waste in Ordu

Municipal solid wastes collected within the borders of Ordu province are passed through the units where separation, size reduction/shredding, screening and homogenization processes at Ünye Mechanical Separation and Transfer Station Facilities. The remaining wastes are collected through the transfer station II. Class Sanitary Landfilling Facility, and biodegradable wastes are sent to the Biodrying Facility (Ordu Province Çaybaşı Solid Waste Disposal Facilities Operation Plan, 2018). In line with the regular landfill works across the province, 23 open dumping areas were closed and improvement works were completed. Then, Çaybaşı sanitary landfilling facility was put into operation. The change in the amount of waste collected in Ordu province over the years is presented in Figure 1.

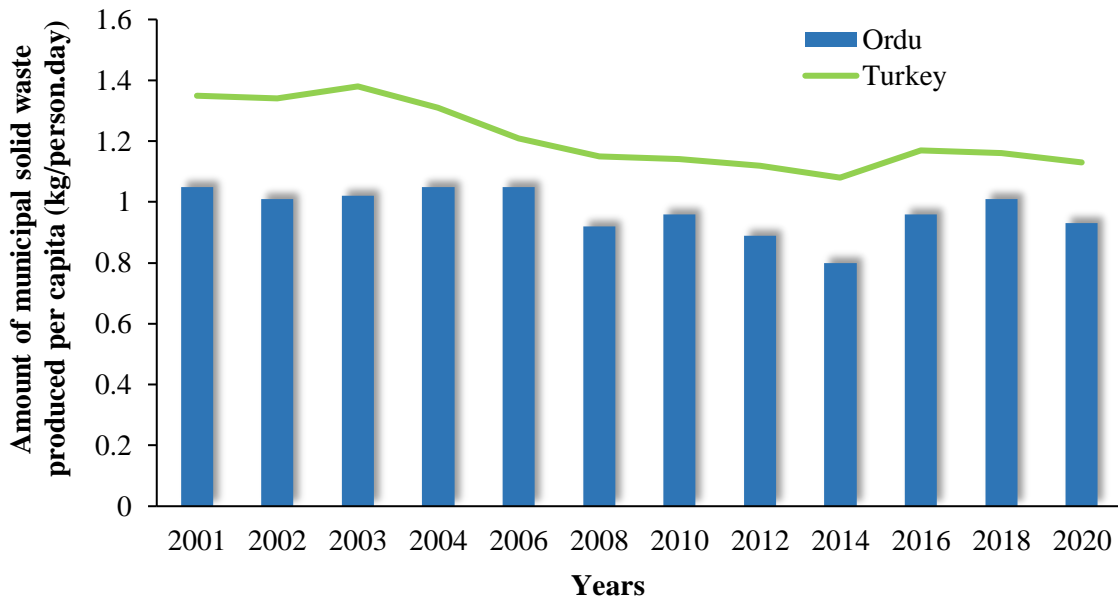
As can be seen from Figure 1, although there are changes over the years in the amount of waste collected in Ordu province, a general increase has been observed in the last 10 years. This increase, which has occurred in the last 10 years, has a strong impact on rapid population growth and technological developments, as well as changes in product diversity and consumption habits. While the amount of solid waste produced in Ordu province was 150.433 tons in 2001, it increased by 60.7% in 2020 and reached 241.859 tons.

The amount of waste produced per capita in the province has decreased in the last 15 years. While the amount of waste produced per person in 2001 was 1.05 kg/day in Ordu province, it decreased to 0.93 kg/day in 2020. The amount of waste produced per capita in the province has decreased by approximately 11.4% in 19 years. It is seen that there is a decrease in Türkiye-wide averages parallel to the situation in Ordu province. While the amount of waste produced per capita in

Turkey was 1.35 kg/day in 2001, it decreased by 16.3% to 1.13 kg/day in 2020. The comparative graph of the amount of waste produced per capita in Ordu province and across Turkey is given in Figure 2. The amount of waste produced per capita in the province remained below the Turkey average between 2001 and 2020.



**Figure 1.** Amounts of municipal solid waste collected in Ordu and Turkey (TURKSTAT, 2023)

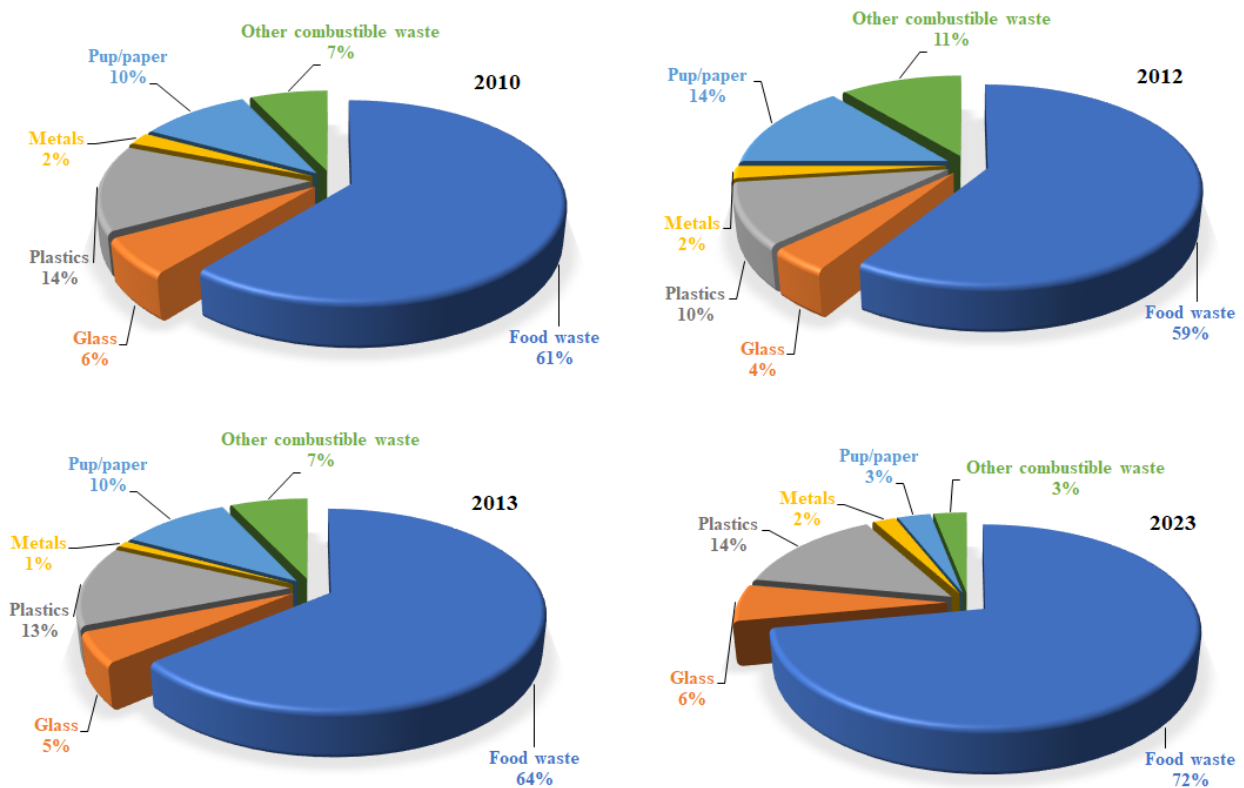


**Figure 2.** Amounts of municipal solid waste produced per capita in Ordu and Turkey (TURKSTAT, 2023)

### 3. Characterization of Municipal Solid Waste in Ordu

Municipal solid waste characterization varies depending on the region where the characterization study will be carried out, population and socioeconomic status. During solid waste characterization, in order to obtain a representative solid waste sample, waste collected from different points of the province (according to income level; low, medium, high) with separate waste collection vehicles was brought to the area where characterization would be carried out. Municipal solid waste composition studies carried out in Ordu Province between 2010 and 2016 are shown in Figure 3.

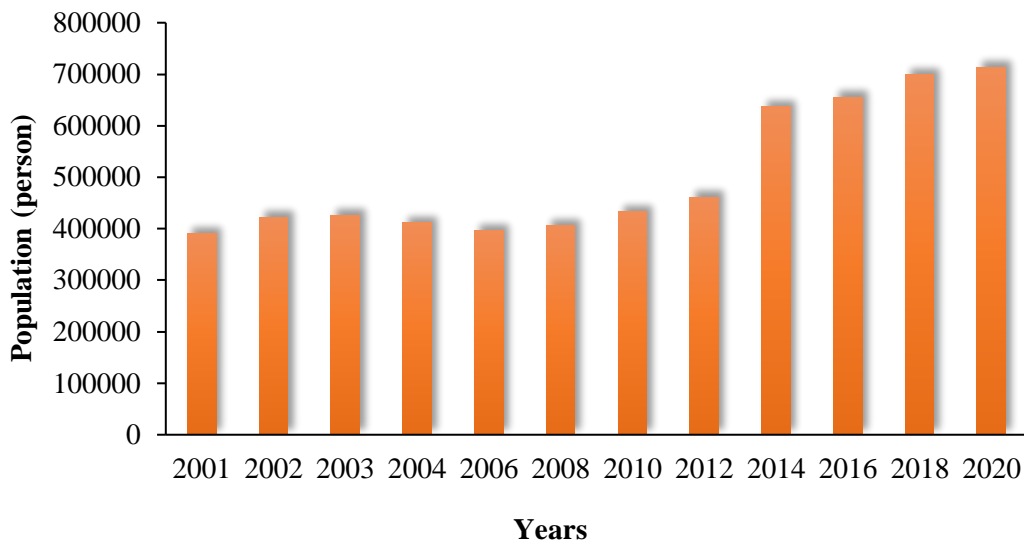
Food waste is the highest waste component in the waste composition throughout the province. Food waste was found to be 61% in total waste in 2010, 59% in 2012, 59% in 2014, and 65% in 2016. Plastic waste was 14% in 2010, 10% in 2012, 10% in 2014 and 7% in 2016. Paper waste was 10% in 2010, 14% in 2012, 13% in 2014, and 4% in 2016. The proportion of the total amount of paper/cardboard, plastic, glass and metal waste in the municipal solid waste composition was 32% in 2010, 30% in 2012, 30% in 2014 and 25% in 2016. The data of the characterization study conducted by Ordu Metropolitan Municipality in Ordu province in different years from 2010 to 2023 are shown in Figure 3.



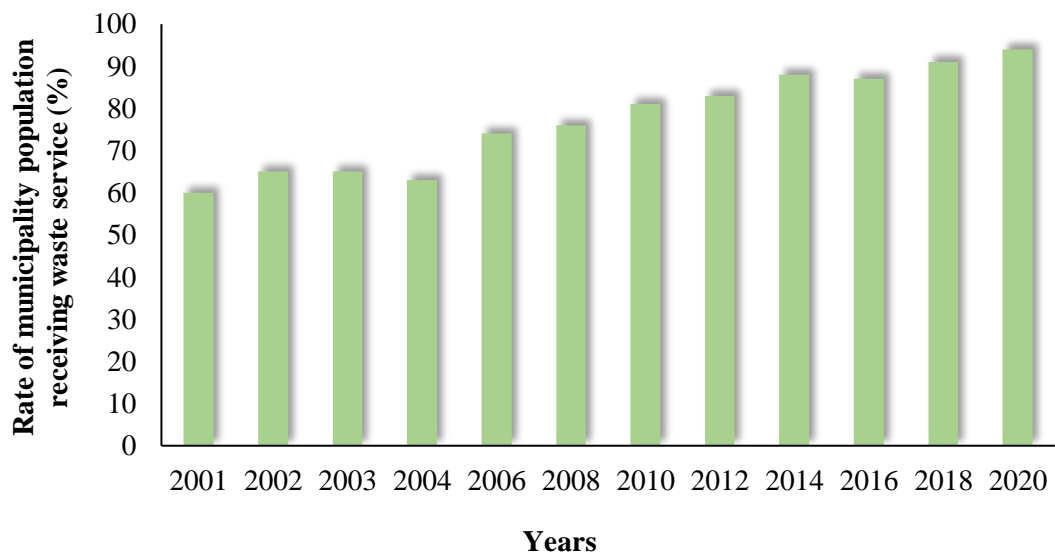
**Figure 3.** Characterization studies of municipal solid wastes conducted in different years

#### 4. Municipal Solid Waste Management in Ordu

According to TUIK data in Ordu province, it is seen that waste collection service was provided to 60% of the municipal population in 2001, and the waste collection service of the municipality increased every year and reached 94% of the total municipal population in 2020. The distribution of the municipality population providing waste collection services in Ordu province by years is shown in Figure 4, and the ratio of the municipal population providing waste collection services to the total population is shown in Figure 5.



**Figure 4.** Population of municipalities providing waste services in Ordu (TURKSTAT, 2023)



**Figure 5.** Rate of municipality population receiving waste service in Ordu (TURKSTAT, 2023)

A dual collection system is implemented throughout Ordu province. Thus, packaging waste and biodegradable waste are collected separately from other waste, the amount of waste going to landfill is reduced and recyclable waste with economic value is used. Municipal and domestic industrial wastes collected in the province are subjected to separation, size reduction/shredding, screening and homogenization processes at Ünye Mechanical Separation and Transfer Station Facilities, and then recyclable wastes (packaging, glass, plastic, etc.) are sent to licensed recycling companies, 80 mm wastes with high calorific value above the sieve are sent to Ünye OYAK Cement Factory, biodegradable wastes are sent to the Biodrying Facility, and the remaining unusable wastes are disposed of in Çaybaşı Regular Landfill.

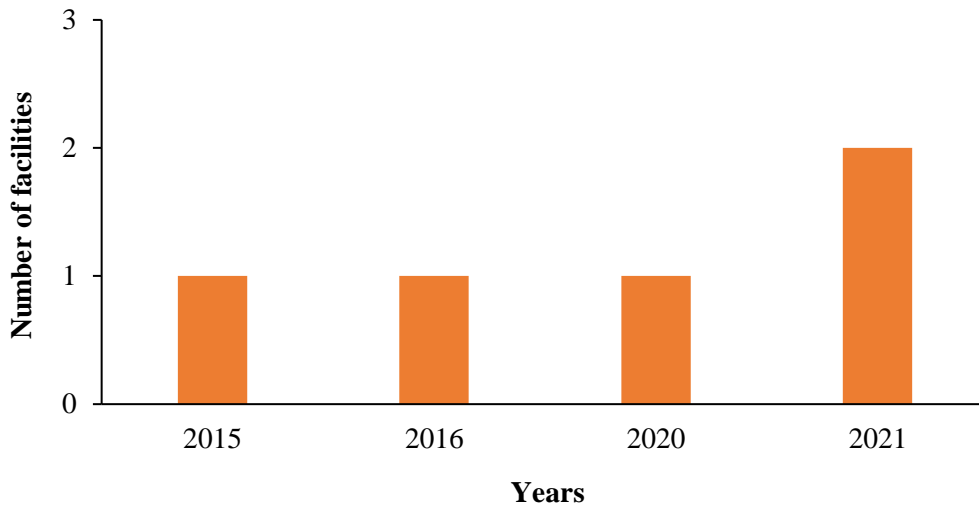
Within the scope of regular landfill works in the province, 23 wild landfills were closed and improvement works were completed. Ordu Metropolitan Municipality's 2nd Stage Regular Storage Facility started operating in 2020 by obtaining a Temporary Activity Certificate within the scope of the Environmental Permit and License Regulation, and received its Environmental License in 2021. The satellite image of the area where Çaybaşı Regular Storage Facility is located is shown in Figure 6.



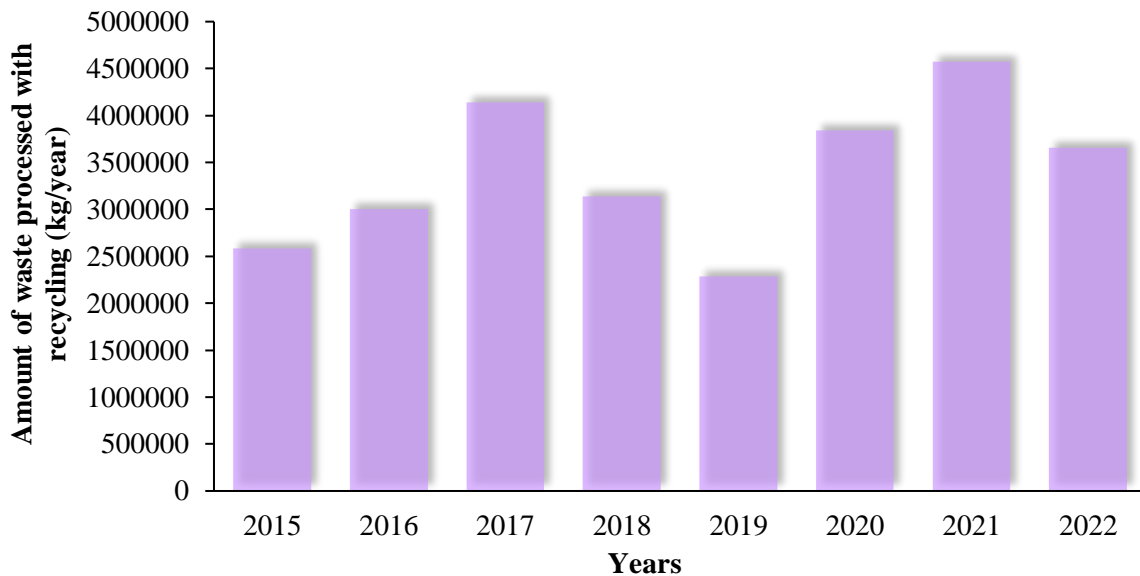
**Figure 6.** Sanitary Storage Facility Location in Ordu

There are transfer stations in Fatsa, Ünye, Kabataş and Gürgentepe districts throughout Ordu province. While the number of Non-Hazardous Waste Recovery facilities in Ordu province was 1 in 2015, 1 facility in 2016, 1 facility in 2020 and 2 facilities in 2021 became operational and a total of 5 Non-Hazardous Waste Recovery facilities operate actively. The change of Non-Hazardous Waste

Recovery facilities over the years is given in Figure 7. The increase in the number of facilities from 2 to 5 by 2020 is an indication that effective zero waste management is achieved throughout the province. In addition, by converting waste into raw materials, the consumption of natural resources has been reduced, contributing to the economy and the amount of waste generated as a result of municipal/industrial activities has decreased. Two Packaging Waste Recovery Facilities in Ordu Province became operational in 2016 and continue to operate actively.



**Figure 7.** Non-hazardous waste recycling facility commissioned in Ordu (TURKSTAT, 2023)



**Figure 8.** Amount of waste recycled in Ordu (TURKSTAT, 2023)

The amount of waste processed by Non-Hazardous Waste Recovery and Packaging Waste Recovery Facilities in Ordu province over the years was 2,998,850 kg/year in 2016, and increased to 3,653,864 kg/year in 2022. The amount of waste processed in the province between 2016 and 2022



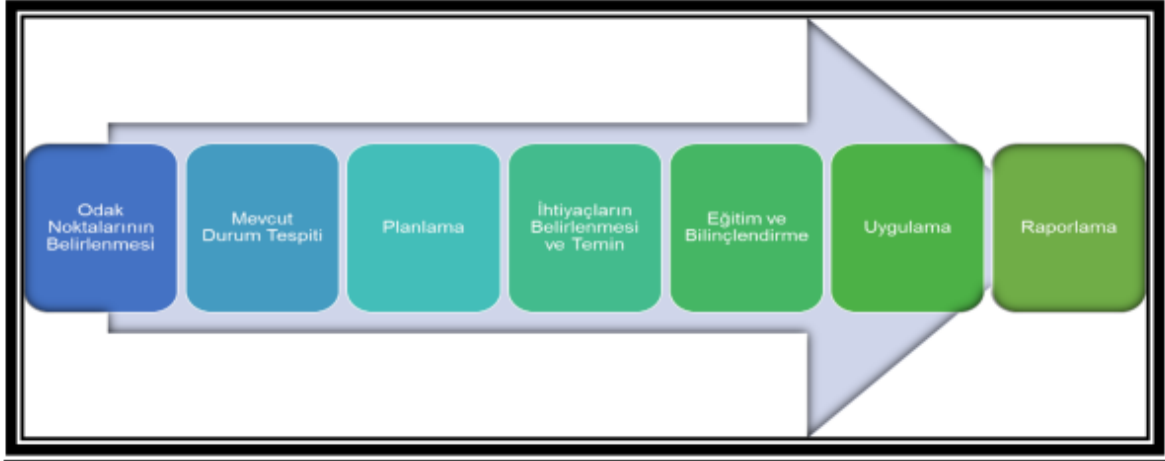
is shown in Figure 8. As can be seen from Figure 8, the amount of recycled waste increased between 2015 and 2017, and then followed a variable course of decrease and increase. It is thought that the increase in recent years is due to people spending more time at home, decreased communication between people, increased consumption activities and more preference for online shopping in Covid-19 cases that emerged worldwide in 2020. Since the number of Covid-19 cases has decreased since 2022 and countries have reduced their measures, the amount of waste that can be recycled has decreased compared to 2020-2021.

## 5. Zero Waste Management in Ordu

Zero waste is a goal defined as a waste prevention approach that includes preventing waste, using resources more efficiently, reducing the amount of waste generated, establishing an effective collection system, and recycling waste.

Establishing the system is an important point in the Zero Waste Project. The establishment of the system constitutes a road map consisting of 7 stages that companies, institutions and organizations must create in order to switch to zero waste, and the steps in question are given in Figure 9. Each stage complements each other. In the zero waste system, the first priority is to prevent waste before it occurs. It includes all practices that prevent waste generation. The next step is to reuse products as much as possible and minimize the use of resources and raw materials. The next step is to create new raw materials and products through physical and chemical processes through recycling and recovery practices. The aim is to both reduce the volume of waste and gain energy by burning waste that cannot be recycled with energy recovery. In this method, air quality monitoring is important and the final waste is sent to storage. With the storage practice, which is the last choice in the Zero Waste Management Hierarchy, it is a method in which waste is not reused as a resource and product, but is ultimately disposed of, and the batches are used and ventilated for a certain lifetime. As a result, with zero waste systems, the burden on landfills is reduced by creating a hierarchy of steps in which waste is used in a continuous cycle.

In order to draw attention to the zero waste project in Ordu Province and to set an example for other public institutions and organizations, the first studies in the province were started in the building of Ordu Governorship and Ordu Provincial Directorate of Environment, Urbanization and Climate Change. Considering the transition schedule to the zero waste management system in the annex of the Zero Waste Regulation, public institutions throughout the province have placed separate collection equipment in their campuses and buildings to collect recyclable waste (paper, glass, metal, plastic, etc.) separately.



**Figure 9.** Zero waste road map

Almost all of the public institutions in Ordu Province and other institutions/organizations included in the Zero Waste Regulation transition calendar have registered with the integrated environmental information system of the Ministry of Environment, Urbanization and Climate Change and have started to use the zero waste information system. During the transition to the zero waste project, local administrations started to collect packaging waste separately from household waste. The Zero Waste Management Plan of Ordu Province was approved by the local environmental board decision dated 22.09.2020 and decision number 20.

The number of public institutions/organizations and facilities that received a basic level zero waste certificate in 2022 across the province is 265. In Ordu Province, there are 1598 public institutions/organizations registered in the zero waste information system of the Ministry of Environment, Urbanization and Climate Change, and 19 municipalities. In 2020-2022, zero waste training was given to public institutions and organizations throughout Ordu province and all faculties on the Ordu University campus by the Ordu Provincial Directorate of Environment, Urbanization and Climate Change.

In the main service building and buildings in the district municipalities and campuses throughout the province, equipment to collect the waste related to the zero waste management system is placed separately, thus ensuring that the waste generated is collected separately and the collected waste is sent to processing facilities through licensed companies. Recycling of packaging waste generated in buildings is carried out by companies that have an environmental license to collect and sort packaging waste.

The resulting waste batteries are collected and delivered to the TAP association, and e-waste is delivered to the TÜBİSAD (Information Technology Industrialists Association). In addition, double collection is made in public institutions and buildings throughout the province. Recycling waste sorted at the source is delivered to the district municipality collection system or environmentally

licensed packaging waste collection and separation facilities by public institutions and organizations with zero waste certificates. Between 2020 and 2022, 1400 institutions, organizations and businesses in Ordu Province received a Zero Waste Certificate.

## 6. Conclusions

Municipal solid waste consists of approximately 69% organic waste and 7% hazardous and non-recyclable waste in Ordu. The recycling potential of municipal solid waste in the province is 24%. Zero waste management includes public institutions and organizations, local governments, industrial facilities, hospitals, educational institutions, tourism facilities, workplaces, in short, all areas that produce waste. During the transition to a zero waste project throughout Ordu Province, local administrations' collection of packaging waste together with municipal waste caused problems in waste management. With the zero waste project, packaging waste collected separately has started to be recycled. Equipment for separate collection has been installed in public institutions and organizations. Although the transition period to the zero waste management system has expired according to the transition calendar in the annex of the Zero Waste Regulation of the Local Administrations, an effective zero waste management has not been achieved because they have not yet established waste collection centers and mobile waste collection centers are not available in all district municipalities. Since temporary waste storage areas have not been established in all buildings and campuses belonging to public institutions and organizations and local administrations, the resulting waste cannot be stored, which causes local administrations to receive waste on a daily basis. This situation also increases the workload. In this context, temporary storage areas should be urgently installed and made functional.

Municipalities do not actively start to collect packaging waste and organic (domestic) waste from households separately, which causes waste to be mixed with each other. The fact that the district municipalities cannot place separate collection equipment on the streets (such as cages for packaging waste) in sufficient numbers and the absence of mobile waste collection and waste collection centers does not make it possible to collect special wastes such as pharmaceutical waste and electrical and electronic waste. For an efficient zero waste management, first of all, it is necessary to raise public awareness of environmental problems, to include courses on zero waste awareness in the curriculum of educational institutions, especially in educational institutions, to carry out public awareness and informing (visual, written, practical) works on zero waste by local governments in the field at certain periods and It is necessary for responsible institutions to audit whether all stakeholders fulfill their duties and responsibilities in national legislation.

## Authors' Contributions

All authors contributed equally to the study.

## Statement of Conflicts of Interest

There is no conflict of interest between the authors.

## Statement of Research and Publication Ethics

The author declares that this study complies with Research and Publication Ethics.

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